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Sunspots and Weather.

By C. E. P. BROOKS, M.Sc.

THE recent development of an unusually large sunspot with associated electrical and magnetic phenomena on the earth has raised again the perennial question of the relation of sunspots to terrestrial weather. But although the literature of the subject is enormous, we are still far from definite conclusions; what we have realised is its complexity.

When sunspots were first discovered and were attributed to variations of solar activity, the idea of connecting them with changes in the earth's temperature followed naturally, and as long ago as 1651 Riccioli concluded that temperature rose with decreasing sunspots, and *vice versâ*. In 1844 the discovery of an eleven-year periodicity in spots caused a renewal of the study, and in 1873 Köppen published results of a very complete investigation showing that temperature reaches a maximum shortly before spot minimum and a minimum about spot maximum, the range averaging 1·3° F. within the tropics and 1·0° F. in temperate latitudes. It has since been found that at stations where mean daily maximum and minimum temperatures are available the former show a much closer inverse relation to sunspot numbers than the latter, so that, as a rule, in the tropics the mean daily range increases towards spot minimum.

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About the time of Köppen's investigation Lockyer discovered that the sun is radiating most heat at spot maximum; this variation has since been determined as nearly 5 per cent.

Solar variations undoubtedly cause marked fluctuations of terrestrial magnetism and auroral frequency, but there is no evidence that either of these elements is a factor of weather, and, so far as we know, solar influence acts entirely through these comparatively small changes in radiation, and these changes, as we have seen, when averaged over a year are in the opposite direction to the variations of terrestrial temperature.

Blanford (1875) suggested that the paradox was due to increased cloudiness at spot maximum resulting from greater evaporation over the water areas, with consequently greater rainfall, both cloud and rainfall lowering the temperature of the land areas. In conformity with this, various authors have found a positive correlation of sunspots with rainfall in the tropics and also with elements such as lake levels, which depend on rainfall. The most remarkable case is the level of Lake Victoria Nyanza which, for the period 1896 to 1915 gave a coefficient of $+\cdot 80$. Blanford's theory involves an opposition between the variations of temperature over land and water areas, which may or may not be true. In the future a study of the temperature variations in the free air will probably throw much light on this problem.

Poey, in the West Indies, and Meldrum, in the Indian Ocean, have demonstrated a close parallelism between the curves for sunspots and the number of tropical hurricanes, but for the West Indies this parallelism is denied by Fassig. Mean pressure in the tropics is in general lowest at spot maximum, but the relationship is nowhere close.

Outside the tropics the reaction of terrestrial weather to sunspots is mainly indirect, through the medium of areas of high and low pressure. In America Kullmer and Bigelow have found that at spot maximum the storm tracks shift a degree or two southward, and also concentrate on the Atlantic coast, while at the same time the absolute storminess increases; at spot minimum the reverse holds. A study of eleven years' wind data in the Falkland Islands also suggests that at spot maximum the storminess is greatest.

In Europe at spot maximum the storms appear to travel chiefly along the Atlantic coast and, to a less extent, through the Mediterranean, while at spot minimum the interior of the continent is more favoured. But in spite of this the eleven-year period in rainfall, though probably

real, is very vague, and in Europe at least it is completely masked by a 5·6-year period. The distribution of the phase angles of this half-sunspot period, as determined from the period 1850 to 1905, is very interesting. Over the whole of northern and western Europe from Finland and Scandinavia through Germany, Great Britain, and France to Italy the maximum rainfall occurs from six to fifteen months after spot maximum and minimum. A similar variation has been found by A. Wallén in the level of the great Swedish lakes, but retarded a few months. This area is separated by a very sharp line from Eastern Europe—Poland, Austria, and Russia (except Petrograd)—in which the phase angle is rotated through about 90 degrees, so that the rainfall maximum occurs a year before spot maximum and minimum. The amplitude of the variation is 10 per cent. on either side of the mean rainfall. This double sunspot variation was explained by Hellmann as due to a combination of two causes—the direct effect of the solar variations on the weather of Europe and the indirect effect due to changes brought about in the circulation at the equator. This hypothesis still requires verification.

The eleven-year period is much complicated by the fact that terrestrial weather also shows relationships with the occurrence of solar prominences, which have a periodicity of $3\frac{3}{4}$ years. This relationship is especially marked in the case of pressure, and has recently been used by C. Braak with some success in seasonal forecasting for Java. On the whole this short period dominates the eleven-year period in terrestrial weather, perhaps because it is reinforced by purely terrestrial cycles of about the same length. There is also a two-year periodicity which still further complicates matters.

An attempt in a different direction was that of G. T. Walker, who made direct correlations of sunspots with pressure, temperature and rainfall. The coefficients obtained, though fairly definite in some districts, were nowhere high; this is partly owing to the lag in terrestrial effects following the maxima or minima of sunspots. The present writer avoided this by taking advantage of the fact that after smoothing over eleven years the sunspot numbers show a steady decline from 1870 to 1913; he accordingly calculated the "secular variation" of pressure, temperature and rainfall over this period. These two investigations gave similar results, tending to show that numerous sunspots cause an increase in the intensity of the atmospheric circulation, with a deepening of the lows, *i.e.*, greater storminess, and an intensification of the highs. It also appeared that at times of many sunspots the "abnormality" or departure from the

mean is greatest, so that numerous sunspots may give drought or flood, great heat or great cold, while a year of few spots will be a normal year.

All these investigations refer to variations in the average spotted area of the sun during a year. The sudden appearance for a short time of a large and vigorous spot may appreciably affect the sun's radiation while it is visible without making much difference to the annual average. The influence of such short variations in solar radiation has been investigated recently by H. H. Clayton, of the Argentine Weather Service. Clayton's results are very complex, and only the briefest summary can be attempted here.

He finds that in summer at Buenos Aires an excess of solar radiation is followed after a day or two by high temperatures ; in winter the effects are irregular, but on the whole reversed. In conformity with the results of other investigations the greatest effect on weather is found to be due to spots near the limb of the sun. Finally, this article may close with the following quotation, very *apropos* for the present phenomenon, which appears to contain a good deal of truth :—

> "(1) If there were no variation in solar radiation the atmospheric motions would establish a stable system with exchanges of air between equator and pole and between ocean and land in which the only variations would be daily and annual changes set in operation by the relative motions of the earth and sun ; (2) the existing abnormal changes which we call weather have their origin chiefly, if not entirely, in the variation of solar radiation."

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OFFICIAL NOTICES.

Issue of Meteorological Reports by Wireless Telegraphy.

ARRANGEMENTS have been made for the issue of the observations made at 1 h. G.M.T. at stations in the British Isles in a collective message from the Air Ministry at 6 h. G.M.T. It is hoped that these messages will prove of considerable value to those stations where wireless watch is not maintained during the night, because it will enable them to construct a chart for 1 h. two hours before the chart for 7 h. is available. In the summer months this is of special importance. The report is issued in the same code as that for other collective messages (*see Meteorological Magazine*, February 1921, p. 5).

From the same date (June 1st) reports from ships in the Atlantic, when they are received, have been included at the end of the collective messages issued from the Air Ministry. These reports (in figure code) are preceded by the word "Ships." The figure groups give the position of the ship, barometer, wind, temperature, visibility, cloud and weather. The details of the code will be supplied on application to *The Director, Meteorological Office, Air Ministry, Kingsway, W.C. 2.*

A further improvement, also introduced from June 1st, is the inclusion of 10 h. observations at Valencia Observatory, Renfrew and Plymouth in the route report issued at 10 h. 35 m. G.M.T.

The first and last of these arrangements are the result of the Anglo-Franco-Belgian conference on questions associated with Aeronautics, held at the Air Ministry in May 1921.

Meteorological Stations.

Holyhead.—The Experimental, Anemometrical and Telegraphic Reporting Station at Holyhead has been taken under the direct control of the Meteorological Office from June 1st, 1921. Hitherto the station has been under the supervision of the Harbour Engineer.

Holyhead has been a telegraphic reporting station since 1861, and anemometer records have been made continuously since 1869. The Stokes "Bridle Anemometer," first used at Holyhead, is now in the Science Museum. An account by Mr. R. H. Curtis of the anemometers at Holyhead, with comparisons of the exposures and records, will be found in the *Quarterly Journal of the Royal Meteorological Society*, Vol. XXII., 1896, p. 235.

In 1813, the telegraphic reporting station was removed from the Sailors' Home and amalgamated with the anemometer station at Salt Island.

The station is now in the charge of Mr. S. T. A. Mirrlees; and Mr. W. Davies, who has been observer for some years, is still to hold that position.

Shaftesbury.—Mr. A. Macdonell, of the Abbey House, Shaftesbury, who has been responsible for this station since 1915, is unable to carry on the observations, owing to change of residence. The work will be taken over by Mr. G. P. Barter, The Old Rectory, Tout Hill, Shaftesbury.

Royal Agricultural Show.

THE Royal Agricultural Show is to be held this year at Derby from June 28th to July 2nd. The Meteorological Office is exhibiting diagrams and instruments illustrative of the relation between weather and agriculture. A climatological station will be in operation, pilot balloons will be sent up, and forecasts will be issued daily.

Official Publications.

Cloud Forms. 1921. Price 1s. 6*d.* net.

"Cloud Forms," first published in 1918, is now issued in a second edition. The original photographs and text have been reproduced, and an appendix has been added to include a set of Captain Douglas's pictures of clouds photographed from above. Space has also been found for an additional photograph by Mr. G. A. Clarke showing a ripple-marked squall cloud.

British Meteorological and Magnetic Year Book. Part III (1). *Daily Readings at Meteorological Stations of the First and Second Orders,* 1920.

THIS volume is issued in continuation of the annual series of "Meteorological Observations at Stations of the Second Order," which have been published since 1873. It consists of tables of daily observations made at 9 h. and 21 h. at eight selected stations in the British Isles. An annual supplement is included, which gives mean values for each month and for the whole year, of the various elements at eleven stations, together with extreme temperatures and maximum rainfall.

"Geophysical Discussion" in the Rooms of the Royal Astronomical Society.

ON May 6th, at 5 p.m., Sir Napier Shaw opened a discussion on "The Structure of the Atmosphere up to 20 kilometres," Dr. G. C. Simpson being in the chair. Sir Napier commenced by describing the actual distribution of temperature in the atmosphere, pointing out that the coldest regions of the whole atmosphere are in the stratosphere above the equator, and that the isothermal surfaces in the stratosphere are approximately vertical. The most interesting places from which to take observations of the stratosphere would be the poles and the equator; but unfortunately the poles are in regions inhospitable for observers, and at the equator the tropopause, the level at which the temperature ceases to decrease with height, is so high as to be rarely accessible to a balloon.

The distribution and thermodynamics of water vapour formed the chief topic of the paper. If the mixing of the air were complete and there were no evaporation, the vapour pressure everywhere would be controlled by the saturation pressure at the coldest part of the stratosphere. As things are, the curves showing the observed variation of temperature with height march well with the adiabatics for saturated air. This is true for Batavia, the British Isles, and Canada, and for Pavlovsk in summer, but not for McMurdo Sound on the coast of the Antarctic Continent. The ascent of a mass of saturated air stops when the air gets cold enough for its environment; in particular, in winter at McMurdo Sound it cannot rise even from the ground, on account of the temperature inversion there.

If the moist air rose to the tropopause, its water falling as rain as it did so, and were adiabatically compressed as it came down again, it would attain a temperature of 350a on the ground. Hence heat must be lost somewhere on the way. With an entropy-temperature diagram the relations of heat

to work can be considered; it can be shown that for equatorial air saturated at about 300a, the troposphere, regarded as a heat engine, must have an efficiency of about 25 per cent., for colder or drier air the efficiency is less.

Slides were shown to indicate the distribution of water vapour over the surface of the earth and the general circulation of the atmosphere at different levels. The latter were regarded as illustrating the flywheel of the atmospheric engine, the kinetic energy of which was estimated.

In the discussion, the Chairman insisted on the need for an explanation of the suddenness of the tropopause. Colonel E. Gold considered that a reasonable explanation of the division of the atmosphere into stratosphere and troposphere had been furnished. If radiation permitted convection would go on throughout the whole atmosphere, but radiation set a limit below which the temperature of the air could not fall and this, in time, fixed a limiting height above which convection could not be effective. Mr. W. H. Dines discussed the correlations between pressure and temperature at the same height, and suggested that their explanation is to be sought on dynamical grounds rather than on pure thermodynamics. The negative correlation between pressure and temperature at a height of 10 km. is particularly difficult to account for by purely thermo-dynamical reasoning. Dr. Jeffreys pointed out that the same term "convection" is used to denote two quite different phenomena, the local and irregular convection caused by the lapse-rate becoming too great for stability, and the regular type arising from differences of temperature between points on the same level. He also pointed out that on theoretical grounds regular vertical motion in the atmosphere must be extremely slow: for a steady motion without friction there would be no vertical motion at all.

Royal Meteorological Society.

THE usual monthly meeting was held on May 18th, 1921, in the Society's rooms, Mr. R. H. Hooker, M.A., President, in the chair.

Mr. J. E. Clark presented the Report on the Phenology of the British Isles, December 1919 to November 1920, drawn up by himself and Mr. H. B. Adames.

Returns from 212 stations, more than double the number of the preceding year and 80 above the previous highest, 1914, make the results exceptionally complete. The early months of 1920 were unusually mild and wet and the spring flowers were out a fortnight before their normal times. The succeeding flowers became less and less early until the two of July were just average.

The charts for the year indicate a delay in flowering of six days for every degree to the north. The report also deals with bird migrations and the time of appearance of insects.

At the same meeting Dr. E. J. Salisbury gave a paper on "Phenology and Habitat with special reference to Woodlands." This paper brought out how far the life-processes of plants depend on sunlight as well as on temperature. The lowlier plants of the woodlands can only obtain a reasonable share of sunshine when the great trees are leafless, and it results that these small plants flower much earlier than similar species growing in the open. Moreover, whilst the average date at which woodland herbs which lose their foliage in winter begin to develop new leaves is February 19th, the shrubs begin a month later and the trees towards the end of April. When the trees are in full leaf the diminished light in the wood may be only one per cent. of that in the open.

Meeting at Edinburgh.

It is proposed to hold an ordinary meeting of the Society in Edinburgh on September 7th. The British Association hold their 1921 meeting in Edinburgh from September 7th to 13th, and the occasion offers an opportunity for the Fellows of the Society on either side of the Border to meet their colleagues. A "Meteorological Luncheon," and an excursion of special meteorological interest, are also under consideration. Fuller particulars will be announced later.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

The Highest Aerial Sounding.

In an article published in the *Monthly Weather Review* for November 1920 Mr. W. R. Gregg discusses the note by Mr. Whipple in a recent number of the *Meteorological Magazine*. Mr. Gregg writes :—

"The sounding-balloon ascensions made in this country show, in practically all cases, an increasing rate of ascent with increasing altitude. In 20 ascensions at Fort Omaha, Nebr. and Huron, S. Dak., the mean rate increased from 180 metres per minute near the surface to 300 at 15 kilometres. In seven ascensions at Avalon, Calif., the mean rate increased from 185 metres per minute near the surface to 295 at 18 kilometres. Objection may be raised to these records as reliable evidence, since the heights were themselves computed from the pressure records. This is true in the cases cited, but in 1914 several balloons were followed by two theodolites at Fort Omaha, Nebr. A base-line 5,088 metres in length was used.

The results indicated close agreement between altitudes determined from triangulation and those from the barograph. Using only those ascensions in which the balloons were followed by two theo dolites, we find that the mean rate of ascent increased from 150 metres per minute near the surface to 240 at 17 kilometres. The increase is fairly constant at all altitudes below 15–18 kilometres, and is practically the same in the individual ascensions. It seems certain, therefore, that the height reached by the Pavia balloon was considerably greater than that computed on the basis of a constant rate of ascent. It seems also quite certain that that height was considerably less than 35 kilometres.

Mr. Whipple inquires what sounding is the highest on record, if the Pavia record is to be deprived of that distinction. So far as known, the next highest observation published is that made at Avalon, Calif., on July 30, 1913. As computed from the barograph trace, an altitude of 32,640 metres was reached. The pressure was 7·4 millimetres. The rate of ascent was about 100 metres per minute near the surface, 275 at 16 kilometres, and 520 at the highest altitude."

Mr. W. R. Gregg has also been so good as to communicate the following additional information for publication in this Magazine:—

"Our best balloons were obtained, before the war, from the Russian-American India-Rubber Co., St. Petersburg. They were of extraordinarily fine quality, better than any others ever tried. In fact, since the war, we have been quite unable to procure any balloons at all suitable. These Russian balloons, unstretched, were of two sizes—4 and 5 feet in diameter, weighing 5 and 9 lbs. respectively. The larger balloons were used singly, the smaller in pairs. In the ascent made at Avalon two small balloons were used; in those at Fort Omaha and Huron one large one was used.

"The extra load to be carried, including the meteorograph and the "free lift," was about 3 lbs.; hence, it was necessary to inflate the two small balloons each to a diameter of 5·6 feet. In order to reach a height where the pressure was 7·4 mm., these balloons would have to stretch to a diameter of 26 feet. In other words, the linear stretch of the rubber was about 550 per cent.

"Replying to your question, I regret to say that no actual tests were made on these balloons in this country. Presumably such tests were made by the manufacturers, however, since in their quotation they guaranteed inflation to 4 or 5 diameters (300 to 400 per cent.) Moreover, pieces of one of the burst balloons were submitted to the U.S. Bureau of Standards two years after the balloons were received, and the tests conducted on these pieces showed that on the average the rubber was capable of stretching 900 per cent. In view of these facts it is reasonable to suppose that the balloons used at Avalon actually reached a height where the pressure was 7·4 mm., as recorded.

"The reason for the increasing rate of ascent is difficult to explain. If there were no diffusion of gas through the rubber, the rate of ascent should vary as the 6th root of the density and would therefore, increase, but, as is well known, there *is* such diffusion. Possibly the difference in temperature of the gas and the outside air has some bearing on the problem. Again, the balloons carry a meteorograph which constitutes a material part of the weight of the system, whose cross-section, however, unlike that of the balloon, remains constant. With decreasing air-density the resistance offered becomes less also. The whole question is in an unsettled state, and is, I think, worthy of some study by anyone having the necessary time to devote to it. "W. R. GREGG.

"*Weather Bureau, Washington, March 19th, 1921.*"

Velocity of Vertical Air Currents.

WITH reference to the point raised by Captain Durward, ascending currents of six miles per hour or more are by no means uncommon, but descending currents of a like magnitude are extremely rare. Strong descending currents seldom exceed two or three miles per hour. In the long series of two-theodolite ascents at Shoeburyness, only a few such cases have been noted. I have noted appreciable downward currents on fine days, with detached cumulus, in the gaps between the cumulus clouds, but usually the balloon passes out of these currents in one minute.

Quite a striking case was the ascent at Shoeburyness on April 15th, 1921, at 10 h. 50 m. G.M.T. The balloon was filled to ascend 500 feet per minute, and the wind was north-westerly, 25–30 feet per second. The state of the sky was given as "Detached cumulus."

Time.	Height in Feet.	Ascending Current.
		Ft./sec.
1	386	−1·9
2	696	−3·3
3	1,027	−2·8
4	1,362	−2·9
5	1,678	−2·9

After the first five minutes no appreciable vertical currents were observed. In this case the descending current of 3 feet per second, or 1 metre per second, extended up to about 1,700 feet.

This is the most striking case shown in many hundreds of two-theodolite ascents. Mr. Clarke's results are therefore of considerable interest in that they show quite unusually strong downward currents. I should be inclined to ascribe them to the topography of the country round Aberdeen, *i.e.*, as hydro-dynamical rather than thermal effects.

D. BRUNT.

April 30th, 1921.

The Dry Weather: A Contrast in Rainfall.

THE rainfall from January 1st to May 31st has been the smallest in my recollection, with the single exception of 1911, when it was exactly the same, viz., 7·57 ins. A comparison with last year's is instructive.

Month.	Average for 15 Years.	1920.	1921.
	Ins.	Ins.	Ins.
January - - - - - -	2·69	4·78	3·34
February - - - - -	2·50	1·01	0·17
March - - - - - -	3·44	4·50	2·36
April - - - - - -	2·35	5·81	0·56
May - - - - - -	2·51	2·72	1·14
Total - - -	13·49	18·82	7·57
Difference from Average - -	..	+5·33	−5·92

The drought this year has therefore been more pronounced than was the excessive rainfall last year, though it has never been "absolute." The first twenty-three days of February were only broken by two falls of ·01 inch each, and no rain fell after May 14th till the evening of the 29th. A remarkable feature has been that the normally drier Midlands and east (including London) had a heavier fall, at any rate in April and May, than this western district, which has almost entirely escaped the Icelandic depressions moving from north-west to south-east across the country, especially in April. These have given rain to a lower latitude in the east than in the west. We also entirely escaped the depression which spread from France on May 26th across the Midlands and eastern counties. The air throughout May was remarkably dry and harsh. The grass on my lawn was getting brown and burnt in the last week of the month, and a very light hay crop seems now inevitable. R. P. DANSEY.

Kentchurch Rectory, Hereford, June 2nd, 1921.

Units for Meteorological Work.

Having been interested in the recent correspondence in your Magazine regarding Meteorological Units, I venture to add a few words in agreement with Messrs. Hurnard and Cross.

While the new units are doubtless of some use for international comparisons, etc., their advantages seem to be over-balanced by their drawbacks. It appears very desirable that meteorology should be made interesting to the general public, but this will hardly be done when units are used which convey absolutely nothing to them While any educated person will grasp the meaning of the older scales, comparatively few will comprehend the new ones, and consequently tables containing these will probably be thrown aside and thought no more of.

If it is wished to confine meteorology to a few experts, by all means use the new units, but if it is desired to popularise it, surely our old methods of measurement are simpler and better for the purpose. E. W. M. Murphy.

Ballinamona, Cashel, Co. Tipperary, May 28th, 1921.

I too should like to protest against the introduction of the millimetre, in preference for the inch, in British rainfall observation.

My thoughts on the subject are so well expressed by Mr. Samuel F. Hurnard in the May number of the Magazine that all I need add is that I endorse what he says there most heartily. Basil T. Rowswell.

Les Blanches, St. Martin's, Guernsey, June 4th, 1921.

Recent forms for recording rainfall require the noting not only of the number of falls of ·01 inch and upwards, but also of the number of those of ·04 inch and upwards. If this is intended with a view to comparison with millimetre records, surely the limit should be ·02 instead of ·04 inch. Anything between ·005 inch and ·015 inch is reckoned as ·01, so I presume that anything between ·02 and ·06 inch would be reckoned one millimetre in a metric record.

F. J. Wardale.

Shrewton, Wilts, May 31st, 1921.

[Mr. Wardale's point would have great force were records of rainfall made in millimetres read only to the nearest whole millimetre. The actual readings are, however, made in tenths, and the precise minimum amount actually counting for a "wet day" is therefore 0·95 mm., equivalent to ·037 inch. On the inch scale the minimum in practice is ·035 inch.—Ed. M.M.]

Early Morning Convective Instability.

The occurrence of violent atmospheric instability in the early morning is rare, and the following instance is interesting.

At 6 h. on May 1st, 1921, the cloud forms observed at Lenton Fields, Nottingham, suggested considerable instability. Small cumulus clouds were forming all over the sky, with protuberances, in some cases long slender columns, projecting from the upper surfaces. In the south-west there were sheets of stratus, which cumulus clouds with curiously ragged and uneven bases penetrated.

In the north and north-east there was some castellated alto-cumulus as well as detached masses of false cirrus, whilst what appeared to be a vast cumulo-nimbus with a fan of false cirrus at the top threatened imminent thunder. This cumulo-nimbus gradually moved from the north-east till it nearly covered the sky, but by 9 h. it had considerably subsided and by 10 h. only a few stratus sheets remained, and by 12 h. 30 m. these had completely evaporated leaving the sky cloudless.

The previous two days had been extremely clear and cloudless with very low humidity, though the wind, a gentle north-easterly breeze, had been cold. At night the stars had been rather hazy, suggesting the presence of a damp layer at a low level, and this is supported by the fact that the minima on April 29th and 30th had been high (40° F. and 45° F. respectively) considering the almost cloudless night skies. The cause of instability would seem to have been the arrival of cold air from the north above the warm air which had been practically stagnant at night and had lost but little of the heat gained during the previous day.

R. F. T. Granger.

Lenton Fields, May 8th, 1921.

Simultaneous Halo and Corona.

Dr. C. F. Brooks points out in the letter published in the Magazine for May that super-cooled water-drops were not necessarily involved in the formation of the simultaneous halo and corona on the night of December 25th. In that particular instance it is not certain that the drops were super-cooled, but I think that in all probability they were. The clouds appeared very high during the day-time, but there was a warm current from beyond the Azores, probably with a temperature above freezing-point up to at least 10,000 feet. The corona was large and brilliant, but the halo was not bright.

Clouds of various forms consisting of super-cooled drops are of almost daily occurrence. On the other hand, I have come across melting ice-crystals such as Dr. Brooks postulates several times, but without seeing a corona. The possibility should not be ruled out, however C. K. M. DOUGLAS.

A Rainbow at Eye-Level?

ON May 8th, 1921, at 15 h. 30 m., Miss L. M. Flannery and Miss G. Grubb were driving up the steep road from Carrick-on-Suir to Seskin; when more than half-way here and about 300 feet above Ordnance datum, they observed in the east to north-east a horizontal band of rainbow colours, the lightest being underneath, stretching across the Suir valley. The north end rested on the "Welsh" mountains in Co. Kilkenny, the south end disappeared behind and east of the hill they were ascending. Rain was falling in the valley but not on the observers. J. ERNEST GRUBB.

Seskin, Carrick-on-Suir, May 24th, 1921.

[The elevation of the sun at the time would have been 40° 12′ at 15 h. 30 m. G.M.T., and, the angular radius of the primary rainbow being 42°, the crown of such a bow would have been seen almost at eye-level.—ED. M.M.]

The Word "Forecast."

WITH reference to the last sentence in Mr. Bilham's note in the January number of the *Meteorological Magazine*, p. 275, you may be interested to know that the U.S. Weather Bureau meteorologists use the word "forecast" almost exclusively in place of "forecasted." Do English meteorologists ever pronounce the verb "forecast" with the accent on the first syllable, as Americans so commonly do (in defiance of the dictionary)? CHARLES F. BROOKS.

Weather Bureau, Washington, D.C., March 25th, 1921.

[The custom in the Meteorological Office is to place a slight accent on the first syllable of the word "forecast," whether used as verb or noun.—ED. M.M.]

Meteorological Observations at Apia, Samoa.

THE Note on the Observatory at Apia, Samoa, on p. 100 of the *Meteorological Magazine* for May, seems rather to suggest that the initiation of weather observations at this station was of German origin, and due to Weichert, its establishment commencing in 1902. This is probably true with regard to

the resuscitation of weather observations and the establishment of a first-class station at Apia. Mr. R. H. Scott, when Secretary to the Meteorological Council, contributed to the *Quarterly Journal of the Meteorological Society* for July 1879 a discussion, carried out by myself, of observations made at Apia by Mr. J. C. Williams, British Consul at Samoa, for the years 1862 to 1865, the instruments having been supplied by the Meteorological Office in 1861. CHAS. HARDING.

2, Bakewell Road, Eastbourne, June 3rd, 1921.

NOTES AND QUERIES.

Notes on a Solar Halo at Eskdalemuir, April 20th, 1921.

THE morning was calm with a surface visibility of 20 kilometres, tending to decrease: The sky was overcast apparently with cirrus stratus haze, which to the eye appeared stationary; a subsequent nephoscope observation at 8 h. 55 m. showed the cloud to be motionless.

The halo was first observed at 6 h. 45 m. G.M.T. It was then partly obscured by Dumfedling Hill, only the top half with arc of contact being visible.

It increased in brightness until 7 h. 45 m.–7 h. 50 m., when the major portion was visible.

A rough sketch was made and measurements taken during this period of maximum brightness. Measurements were made with a pilot balloon theodolite, but it was only possible to align this by the sights, since the halo was invisible through the telescope. Measurements of the sun's elevation, however, checked later by calculation, were accurate to within 0·4°.

The phenomenon at this time took the form of—

(*a*) A halo of 22° radius with arc of contact whose convex side was towards the sun, and a mock sun ring forming a horizontal diameter* to the circle and protruding for some distance outside the circumference. Inside the circle the ring was distinctly visible although of a lesser brilliance than the extensions on either side.

(*b*) An arc of a halo of approximately 45° radius and apparently concentric with the first.

Sections of brilliant whiteness were observed (i) at the junctions between the halo and parhelia, (ii) on the circumference about 45° below the parhelia. These latter were quite

* The development of the mock sun ring inside the 22° halo, but not far beyond it, is rare.

unmistakable, but do not appear to be mentioned* in any published account of a halo.

The inner edge of the ring assumed a red-brown hue, the remainder being white except at its junction with the arc of contact where the colours were:—Violet on the inside, gradating through Red, Yellow, Green, and Blue to White on the extreme outside edge. These colours were, however, of little brilliance.

As the sun's altitude increased the halo grew fainter, the arc of radius 45° and arc of contact disappearing about 8 h. G.M.T.

At 9 h. 15 m. another arc of contact appeared of a reverse curvature to the first. At this time the mock suns were visible outside the circle only, about 9° from its outer edge. They continued to move away, their distance being 14° at 9 h. 50 m. and 20° at 10 h. 40 m.

About this time Cumuli finally eclipsed the sun.

At 18 h. G.M.T. on the same day a mock sun vertically 22° above the sun was observed, and at 21 h. a lunar halo of the usual type.

A nephoscope observation at 19 h. gave Cirrus from north-east at 0·3 milliradians per second.

The positions found for the parhelia with various altitudes of the sun were in accordance with the accepted theory.

P. F. Jarrold.

A Localised Oscillation of Pressure.

A somewhat unusual form of kink occurred on the barograph trace at Benson on May 8th, 1921, 8 h. 25 m. It consisted of a fall of pressure amounting to about 1 mb., and then a rise again to the original level, the whole rise and fall lasting about 10 minutes. The other recording instruments showed no noticeable peculiarities, though at 8 h. 30 m. a drop in the wind and a small change in its direction were indicated. There was no rain at the time.

The microbarogram and the Dines mercurial barogram at South Kensington for the same day show irregularities between 5 h. and 7 h., but none after that time. Corresponding records at Kew Observatory also show no irregularity synchronising with that at Benson, though the distance between the stations is only 40 miles.

* These patches may perhaps have been degenerate "arcs of Lowitz." These arcs which have only been recorded about six times join the parhelion to points on the lower half of the 22° halo.

A Solitary Cloud-ridge.

ATTENTION having been called to a remarkable cloud effect which occurred about the time of sunset on Wednesday, May 25th, a request for information as to observations was circulated in the Meteorological Office. Extracts from various reports are given below.

Kingston-on-Thames:—

Looking towards the western horizon at Kingston, at 19 h. 55 m. G.M.T. (May 25th), the sky had a very beautiful appearance. From the horizon to about 15° the sky was of a bright orange colour; this gradually faded away to a pink tint up to about 25°. Above this height the sky was a dull grey, until about 30° from the zenith, where a narrow band of cloud stretched right across from horizon to horizon (NNE—SSW). The under side of the band was a very bright red, the upper edge was a dull grey. The edges were not straight, but were slightly waved. By 20 h. G.M.T. the band had lost its bright red colour and was now a very dull grey, almost black.

The predominant cloud was alto-stratus, but patches of lower stratus cloud were visible. Mammato-cumulus cloud could also be seen below the band. The sky towards the eastern horizon was almost completely covered with a uniform layer of alto-stratus cloud, with a few streaks of stratus or strato-cumulus near the horizon. From the horizon to about 5° the sky was cloudless, and of a bluish-yellow tint.

The atmosphere was calm during the phenomena. A heavy shower of rain occurred about 21 h. G.M.T. The average height of the cloud, I should say, was about 10,000 to 12,000 feet, although the patches of stratus were perhaps about 4,000 or 5,000 feet high.

C. C. NEWMAN.

East Twickenham:—

The feature of chief interest was an arch of cloud in the north-west, the apex having an elevation of about 45° when first noticed (about 18 h. 30 m. G.M.T.). By 19 h. 30 m. this arch was almost in the zenith. The arch itself on its lower side presented a wavy structure which suggested that it might later develop into mammato-cumulus. It divided the sky into two halves in which the cloud forms were strikingly dissimilar. On the north-west side there were detached patches of ragged nimbus, while on the south-east side the cloud was of a heavy alto-cumulus type. Such movement as could be detected appeared to be parallel with the arch from south-west, but, as previously noted, the arch itself moved very slowly towards south-east.

E. G. BILHAM.

Chiswick.—

At sunset the arc showing colours was bounded by a narrow arch stretching from horizon to horizon. This arch was a brilliant pinkish red, and as seen from Chiswick the crown of the arch was about 40° north-west of the zenith. Such slight motion as there was was in the direction south-west to north-east. The fold, as it might be called, could be detected long after the brilliant colour had faded away.

F. J. W. WHIPPLE.

Golders Green:—

I was walking back from the golf-course at Hampstead when my eye caught sight of a cloud-line towards the north-west. It consisted of a grey line which seemed to stand out like the back-bone of a whale; above, the cloud was lighter and appeared to recede from the

backbone; below, it also receded, but was narrower and was slightly tinged with a reddish colour. I put the direction of the line of the arch as south-south-west to north-north-east. I have never seen anything like this cloud before. E. GOLD.

At 20 h. the sky appeared practically covered with alto-cumulus cloud. Radiating from a point on the horizon a little south of west was a warm pink glow extending to 45° from the horizon, becoming then too diffused to be noticeable. Around this glow was a band of light, some 10° broad, not unlike a rainbow, but of one colour, the same pink as the upper part of the glow. Some 40° only of this arc was visible. W. G. DAVIES.

The cloud-fold was not visible from South Kensington, as will be gathered from Mr. Spencer Russell's report: "19 h. 50 m. Entire sky from west to zenith a sheet of purple crimson, colour fading rapidly, dissappearing almost entirely by 20 h., leaving an intensely black sky to westwards." The line from Kingston to Golders Green is about 12 miles long. S. Kensington is about $2\frac{1}{2}$ miles to the south-east of this line.

The weather map of May 25th was dominated by a ridge of high pressure crossing central England, approximately from south-west to north-east, and therefore parallel to the "fold" in question. The rainfall which occurred later in the evening was associated with the passage of a small depression.

Sunlight and Health.

IN a letter to the *Times*, June 6th, 1921, Dr. Leonard Hill quotes some measurements recently made by Dr. Sonne, of the Finsen Light Institute. Dr. Sonne has compared sunlight with sources of dark heat, each kind of radiation being taken of the same energy value per unit of surface. After deducting the amount of each kind of radiation reflected by the skin surface, he has found that twice as much sunlight as dark heat is required to burn the skin. The difference is due to the fact that the visible rays of the sun penetrate the skin and are absorbed by the blood circulating in the deep skin and subcutaneous tissue, while the dark heat is mostly absorbed by the skin surface and warms it. Dr. Sonne has found that sunlight may warm up the blood under the skin no less than 5° C. above the temperature to which dark heat warms it; that is, when the surface of the skin in either case is heated to a just endurable degree. The visible rays absorbed by the blood are converted into heat, and the heat carried away by the circulation warms up the body. Exposed to the cooling breezes of open air, the body is kept cool as a whole, while locally the blood and deep skin, in exposed parts, are warmed by the sun to a temperature which may even exceed that of high fever.

This local warming, not excluding other possible results of absorption by the flood of the same visible rays, probably has a profound effect on the immunity of the body to disease. We know that children with tuberculosis of bones, joints, glands and skin respond wonderfully well to conservative treatment in sanatoria, where they are exposed to open-air and sunlight. In the Alpine sanatoria they live naked but for a loin-cloth, winter and summer, kept warm by the sun, and at the same time stimulated by the cool air. It is the visible, not the ultra-violet rays, which stimulate health, for the latter are absorbed by the surface layer of the scarf-skin, having the least protective power.

Dr. Hill concludes that "we must use smokeless fuel and keep the sky clean so that we can enjoy all the possible sunlight." "Has not the time come," he asks, "to interdict the vast waste of human energy, happiness, and health caused by the burning of soft coal?"

Sunshine and Visibility in London.

ATTENTION has lately been drawn to the exceptional clearness of the atmosphere, attributed to the absence of smoke during the coal crisis. The records of sunshine and visibility in London for May are therefore of interest.

The sunshine recorded at Westminster for May 1921 amounted to 227·1 hours. Since 1911 only one May has had a higher record, *i.e.*, May 1919, with 228·1 hours. Observations of visibility are taken twice daily (at 9 h. and 15 h.) on the roof of the Meteorological Office, South Kensington. During May, in 31 observations at 9 h., Big Ben (at $2\frac{3}{4}$ miles) was visible 21 times and St. Paul's Cathedral (at $4\frac{1}{4}$ miles) 10 times, and in 20 observations at 15 h., Big Ben was visible 16 times and St. Paul's 10 times.

The Recent Magnetic and Electrical Disturbances.

THE magnetic and electrical disturbances associated with the large sun-spot which appeared on May 8th have been remarkable for their intensity and persistence. The magnetic storm continued without any considerable break from about 13 h. G.M.T. on May 13th until about 4 h. on May 17th. A quieter interval followed, and then on May 19th and following days notable disturbances occurred. This storm was less persistent therefore than the one in November 1882, which presented very similar features but continued almost without a break for nine or ten days. During the storm

aurora was reported from Cambridge, London, and other stations in southern England, where it is a rare event even at the equinoxes. (An interesting acount of aurora observed at Okehampton has been received from Mr. E. P. Burd.) Large earth currents were observed in the Post Office telegraph system at stations in England, Scotland and Ireland.

The American Meteorological Society.

THE American Meteorological Society was organized on December 29th, 1919, and incorporated in Washington on January 21st, 1920. At the end of the first year of its existence it had 1,035 actual or prospective members. Such rapid progress is, in part, due to the low fees for membership, but, in part undoubtedly, to the great interest in meteorology awakened in America by the war and the development of flying. The first president is Professor R. de C. Ward, a choice which will meet with the approval of meteorologists in all parts of the world, and the secretary is Dr. C. F. Brooks, of the United States Weather Bureau.

While the aims of the American Society are identical with those of the Royal Meteorological Society, the methods by which it is proposed to attain those aims appear to be rather different. Meetings are relatively few, and original papers read at these meetings are to be published in abstract only, not in full. The activities of the Society are intended to be concentrated mainly in the hands of the Committees, of which there are twelve, dealing respectively with Membership, Corporation Membership, Meteorological Instruction, Public Information, Research, and Physiological, Agricultural, Commercial, Business, Marine, Aeronautical and Hydrological Meteorology. It is evident from this list that the Society intends to keep the utilitarian aspects of its science well to the fore. The Committees will be able to meet but rarely, and their business will be transacted mainly by letters and memoranda.

The first annual volume of the monthly publication, termed "*The Bulletin of the American Meteorological Society,*" is now complete. The first volume is necessarily largely preparatory, and much of it is occupied by summaries of articles in "*The Monthly Weather Review,*" and by paragraphs of the "Notes and News" type, but as the various committees and private members get to work we shall expect the "Bulletin" to contain much useful material.

We cordially welcome the advent of the new Society into the meteorological world, and believe that it will be a powerful agent in stimulating and giving expression to the scientific instincts of American students of meteorology, whose broad outlook and thorough methods of research we have frequently had occasion to admire.

News in Brief.

THE METEOROLOGICAL MAGAZINE for February and March 1920 is out of print. If any readers have copies of these issues which they do not wish to retain it would be a kindness if they would return them to THE DIRECTOR, Meteorological Office, South Kensington, S.W. 7, or to THE SUPERINTENDENT, British Rainfall Organization, 62, Camden Square, N.W.1.

Rousdon Observatory.

IT is announced that the wind-tower and the removable buildings of the astronomical observatory at Rousdon are for sale. The wind-tower has a platform nearly 60 feet above ground. An illustration of the tower was published in the *Quarterly Journal of the Royal Meteorological Society*, January 1902.

For particulars, application should be made to Cecil Baker, Esq., Combe Pyne, near Axminster.

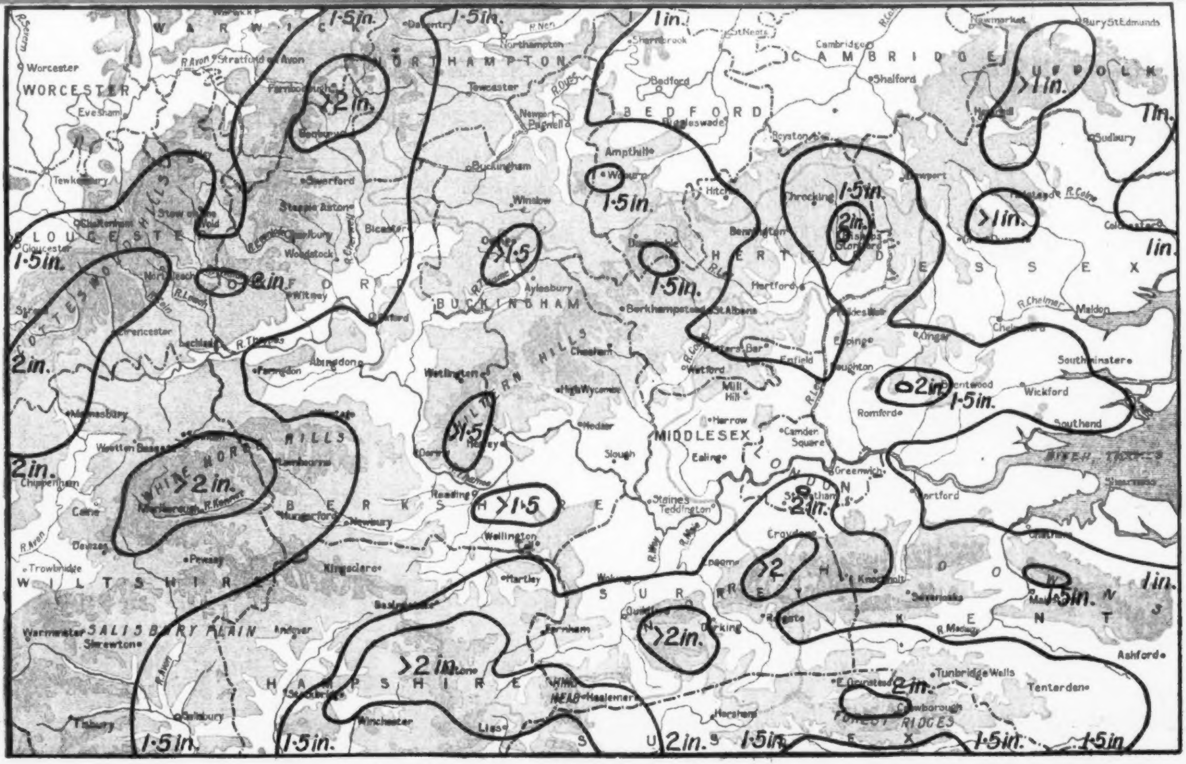
IT is announced that Mr. M. A. Giblett is to act as one of the secretaries of Section A. of the British Association for the Edinburgh meeting. Communications relating to meteorology may be sent to him at the Meteorological Office, Air Ministry, Kingsway.

IT is announced that the Cross of the Legion of Honour has been awarded to the Rev. Louis Froc, S.J., Director of the Zi-ka-wei Observatory, Shanghai.

The Weather of May 1921.

THE weather was on the whole fine and dry over the greater part of the country, but unsettled in the extreme north-west. The features which have hitherto characterised the year 1921 were thus maintained. There was continuous fine weather in southern England from the 16th to the 25th.

At the beginning of the month there was a large anticyclone over Iceland and a depression over northern Scandinavia. The weather on the 1st was fine over the British Isles, and warm, except locally on the coast. Temperature was also high in Iceland. A cold northerly current then extended over the British Isles, reaching southern England late in the evening of the 2nd and continuing till the 4th. Cold showery weather was experienced, with snow in the north of Scotland and night-frosts in places. Between the 5th and the 10th a deep depression skirted the north-west coast and caused unsettled but milder weather, with some rain, in all districts, though not in large amounts. This depression filled up near the Shetlands on the 10th, and



ALTITUDE SCALE. | Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES 0 5 10 15 20

H.M. Stationery Office Press, Kingsway, W.C.2.

P.S.3332/343 Wt.36 D.P.15 1250 6/21.

Meteorological Magazine.

Watershed of River Thames above Teddington and River Lea above Feildes Weir.

Isohyetals.

another depression from the Atlantic filled up over England, causing local thunderstorms on the 12th. The next depression appeared over Iceland, and a well-marked secondary skirted the Hebrides on the 14th, causing unsettled weather generally. In southern England the weather was fine until the night of the 14th, when a small secondary brought rain. By the 16th a belt of high pressure was established from the Azores to the Baltic, which persisted till the 25th, causing a spell of brilliantly fine weather over southern England. On the 25th temperature exceeded 75° F. at many stations. The northern and north-western districts were affected at times by depressions to the northward. On the 25th a secondary trough of low pressure developed over England and France, and thunderstorms were experienced in eastern England in a few places on the night of the 25th and more widely on the 26th. The secondary trough moved east and a cooler current extended over the country from the north-west. On the 25th and 26th there was a northerly gale and snow over Iceland, so that the cold current was drawn from far to the northward, resulting in low upper air temperatures and local hail and thunder over the British Isles. Between the 29th and 31st a deep depression moved north-eastward across the Hebrides, with strong south-west winds over the British Isles, gale force being reached at a few stations. There was heavy rain in the north-west, and smaller amounts elsewhere. On the 31st the depression moved away northward and filled up rapidly, the anticyclonic belt from the Azores to the Baltic becoming re-established on June 1st.

Sea-fog was experienced on the south-west coasts from the 11th to the 13th, and in the English Channel on the 13th and 14th. Otherwise visibility was good, a feature of the month being an unusually large number of observations of exceptional visibility.

In parts of the Continent there was more rain than in England. The cold current about the 3rd extended over a large area, accompanied by secondary depressions, and there was some rain in eastern France and Central Europe, as is usual when polar currents extend over those regions. Belfort had 54 mm. (2·1 inches) on the 2nd and 46 mm. (1·8 inches) on the 4th; while Posen had 60 mm. (2·4 inches) on the 5th. The total for the month at Belfort was 321 mm. (12·6 inches), most of the heavy falls probably being of thunderstorm type. Severe thunderstorms and destructive hail were experienced in southern France between the 18th and 25th, while the weather was fine over England. About the 25th temperature exceeded 80° F. at many Continental stations, reaching 88° F. on that date at Paris. C. K. M. D.

(*Continued on* p. 140.)

Rainfall Table for May 1921.

STATION.	COUNTY.	Aver. 1881–1915.	1921.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	1·76	1·03	26	59	·18	26	12
Tenterden (Ashenden)	*Kent*	1·57	1·78	45	113	·65	2	11
Arundel (Patching Farm)	*Sussex*	1·85	1·81	46	98	·42	7	13
Fordingbridge (Oaklands)	*Hampshire*	2·08	1·51	38	73	·35	14	18
Oxford (Magdalen College)	*Oxfordshire*	1·79	1·13	29	63	·28	14	18
Wellingborough (Swanspool)	*Northampton*	1·94	1·15	29	59	·19	3, 14	13
Hawkedon Rectory	*Suffolk*	1·85	1·11	28	60	·37	2	13
Norwich (Eaton)	*Norfolk*	1·93	1·27	32	66	·38	27	12
Launceston (Polapit Tamar)	*Devon*	2·02	2·34	59	116	·54	9	16
Sidmouth (Sidmount)	,,	1·96	1·81	46	92	·35	9	12
Ross (Chasedale Observatory)	*Herefordshire*	2·13	1·15	29	54	·27	7	13
Church Stretton (Wolstaston)	*Shropshire*	2·58	2·04	52	79	·35	31	17
Boston (Black Sluice)	*Lincoln*	1·76	1·13	29	64	·26	27	16
Worksop (Hodsock Priory)	*Nottingham*	1·99	1·32	34	66	·31	7	13
Mickleover Manor	*Derbyshire*	1·97	1·78	45	90	·29	29	15
Southport (Hesketh Park)	*Lancashire*	2·09	1·45	37	69	·30	14	16
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·14	1·85	47	86	·67	2	13
Hull (Pearson Park)	,, *E. R.*	1·93	2·45	62	127	·47	7	12
Newcastle (Town Moor)	*North'land*	2·03	1·57	40	77	·45	14	10
Borrowdale (Seathwaite)	*Cumberland*	7·37	5·35	136	73	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	2·50	1·95	49	78	·52	29	17
Haverfordwest (Gram. Sch.)	*Pembroke*	2·50	2·18	55	87	·65	29	14
Aberystwyth (Gogerddan)	*Cardigan*	2·64	2·21	56	84	·49	3	8
Llandudno	*Carnarvon*	1·90	1·41	36	74	·35	28	14
Dumfries (Cargen)	*Kirkcudbrt.*	3·01	3·32	84	110	·70	30	20
Marchmont House	*Berwick*	2·47	1·99	51	81	·31	28	16
Girvan (Pinmore)	*Ayr*	2·98	2·55	65	86	·72	30	21
Glasgow (Queen's Park)	*Renfrew*	2·44	..	..	..	..	..	..
Islay (Eallabus)	*Argyll*	2·65	2·72	69	103	·34	30	23
Mull (Quinish)	,,	3·06	4·00	102	131	·47	3	22
Loch Dhu	*Perth*	4·49	5·35	136	119	1·15	30	19
Dundee (Eastern Necropolis)	*Forfar*	2·09	1·88	48	90	·30	25	20
Braemar (Bank)	*Aberdeen*	2·39	2·57	65	108	·65	30	16
Aberdeen (Cranford)	,,	2·48	1·18	30	48	·19	30	13
Gordon Castle	*Moray*	2·12	2·18	55	103	·41	28	19
Fort William (Atholl Bank)	*Inverness*	3·86	6·03	153	156	1·30	30	27
Alness (Ardross Castle)	*Ross*	2·60	3·26	83	125	1·09	28	20
Loch Torridon (Bendamph)	,,	4·56	4·94	125	108	·52	30	21
Stornoway	,,	2·56	3·02	77	118	·40	27	23
Wick	*Caithness*	2·07	1·70	43	82	33	5	20
Glanmire (Lota Lodge)	*Cork*	2·45	1·79	45	73	·59	10	18
Killarney (District Asylum)	*Kerry*	3·06	2·27	58	74	·48	30	20
Waterford (Brook Lodge)	*Waterford*	2·32	2·27	58	98	·78	10	16
Nenagh (Castle Lough)	*Tipperary*	2·47	2·09	53	85	·66	30	20
Ennistymon House	*Clare*	2·80	2·78	71	99	·50	30	22
Gorey (Courtown House)	*Wexford*	2·22	1·83	47	82	·30	25	18
Abbey Leix (Blandsfort)	*Queen's Co.*	2·43	2·25	57	93	·42	7	20
Dublin (FitzWilliam Square)	*Dublin*	2·05	1·53	39	75	·23	8	22
Mullingar (Belvedere)	*Westmeath*	2·45	2·26	57	92	·50	30	16
Woodlawn	*Galway*	2·73	2·09	53	77	·27	5	24
Crossmolina (Enniscoe)	*Mayo*	3·25	2·58	65	79	·39	30	23
Collooney (Markree Obsy.)	*Sligo*	2·74	3·12	79	114	·53	8	20
Seaforde	*Down*	2·63	2·67	68	102	·91	30	13
Ballymena (Harryville)	*Antrim*	2·86	3·52	89	123	·79	30	22
Omagh (Edenfel)	*Tyrone*	2·59	2·22	56	86	·46	30	20

Supplementary Rainfall, May 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	·92	23	XII.	Langholm, Drove Rd.	2·71	69
,,	Sevenoaks, Speldhurst	1·36	35	XIII.	Selkirk, Hangingshaw	2·80	71
,,	Hailsham Vicarage...	1·31	33	,,	North Berwick Res....	1·17	43
,,	Totland Bay, Aston ..	1·14	29	,,	Edinburgh, Royal Ob.	1·63	42
,,	Ashley, Old Manor Ho.	1·64	42	XIV.	Biggar...............	1·57	40
,,	Grayshott...........	2·45	62	,,	Leadhills	4·11	104
,,	Ufton Nervet........	1·26	32	,,	Maybole, Knockdon ...	2·25	57
III.	Harrow Weald, Hill Ho.	1·29	33	XV.	Dougarie Lodge.......	3·48	88
,,	Pitsford, Sedgebrook..	1·47	37	,,	Inveraray Castle......	5·86	149
,,	Chatteris, The Priory.	·70	18	,,	Holy Loch, Ardnadam	..	..
IV.	Elsenham, Gaunts End	1·01	26	XVI.	Loch Venachar	4·55	116
,,	Lexden, Hill House ..	1·03	26	,,	Glenquey Reservoir ...	4·40	112
,,	Aylsham, Rippon Hall	1·82	46	,,	Loch Rannoch, Dall...	2·68	68
,,	Swaffham..........	1·12	28	,,	Trinafour............	3·80	97
V.	Devizes, Highclere ...	1·98	51	,,	Coupar Angus.......	1·82	46
,,	Weymouth..........	2·27	58	,,	Montrose Asylum	1·66	42
,,	Ashburton, Druid Ho.	3·63	92	XVII.	LogieColdstone,Loanh'd	3·00	76
,,	Cullompton	2·26	57	,,	Fyvie Castle..........	1·56	40
,,	Hartland Abbey	1·72	44	,,	Grantown-on-Spey ...	2·12	54
,,	St. Austell, Trevarna .	2·65	67	XVIII.	Cluny Castle	3·19	81
,,	North Cadbury Rec. .	1·94	49	,,	Loch Quoich, Loan ...	11·60	295
,,	Cutcombe,Wheddon Cr.	2·69	68	,,	Fortrose	2·34	59
VI.	Clifton, Stoke Bishop.	1·84	47	,,	Glenelg Manse	3·13	79
,,	Ledbury, Underdown.	1·24	31	,,	Skye, Dunvegan	4·76	121
,,	Shifnal,HattonGrange	1·14	29	,,	Glencarron Lodge	4·70	119
,,	Ashbourne, Mayfield .	1·74	44	,,	Dunrobin Castle	2·63	67
,,	Barnt Green, Upwood	1·57	40	XIX.	Tongue Manse	3·29	84
,,	Blockley, Upton Wold	1·67	42	,,	Melvich Schoolhouse ..	2·29	58
VII.	Grantham, Saltersford	1·61	41	,,	Loch More, Achfary...	4·77	121
,,	Louth, Westgate	1·64	42	XX.	Dunmanway Rectory..	3·01	77
,,	Mansfield, West Bank	1·70	43	,,	Mitchelstown Castle...	1·89	48
VIII.	Nantwich, Dorfold Hall	1·36	35	,,	Gearahameen	4·90	125
,,	Bolton, Queen's Park.	2·84	72	,,	Darrynane Abbey	2·89	73
,,	Lancaster, Strathspey.	3·59	91	,,	Clonmel, Bruce Villa ..	2·60	66
IX.	Rotherham..........	1·05	27	,,	Cashel, Ballinamona...	1·67	42
,,	Bradford, Lister Park.	1·44	37	,,	Roscrea, Timoney Pk..	1·36	35
,,	West Witton.........	1·29	33	,,	Foynes...............	2·05	52
,,	Scarborough, Scalby..	2·44	62	,,	Broadford, Hurdlesto'n	3·19	81
,,	Middlesbro', Albert Pk.	1·08	27	XXI.	Kilkenny Castle.......	1·92	49
,,	Mickleton...........	1·80	46	,,	Rathnew, Clonmannon	2·46	63
X.	Bellingham	1·53	39	,,	Hacketstown Rectory .	2·01	51
,,	Ilderton, Lilburn	1·54	39	,,	Balbriggan, Ardgillan .	2·36	60
,,	Orton...............	4·22	107	,,	Drogheda	2·20	56
XI.	Llanfrechfa Grange ..	1·99	51	,,	Athlone, Twyford	1·80	46
,,	Treherbert,Tyn-y-waun	3·95	100	XXII.	Castle Forbes Gdns....	2·16	55
,,	Llanwrda...........	2·76	70	,,	Ballynahinch Castle...	3·66	93
,,	Fishg'rd,Goodwick Stn.	1·83	47	,,	Galway Grammar Sch.	2·08	53
,,	Lampeter, Falcondale	2·09	53	XXIII.	Westport House	..	..
,,	Cray Station	3·20	81	,,	Enniskillen, Portora...	1·90	48
,,	B'ham W.W.,Tyrmyndd	2·73	69	,,	Armagh Observatory ..	2·06	52
,,	Lake Vyrnwy.......	3·14	80	,,	Warrenpoint	3·37	86
,,	Llangynhafal, P. Drâw	1·43	36	,,	Belfast, Cave Hill Rd..	2·20	56
,,	Oakley Quarries	5·28	134	,,	Glenarm Castle	2·45	62
,,	Dolgelly, Bryntirion..	3·26	83	,,	Londonderry, Creggan.	2·45	62
,,	Snowdon, L. Llydaw.	..	..	,,	Sion Mills............	2·02	51
,,	Lligwy	2·44	62	,,	Milford, The Manse ...	2·20	56
XII.	Stoneykirk,ArdwellHo.	1·93	49	,,	Narin, Kiltoorish	2·58	65
,,	Carsphairn, Shiel.....	4·06	103	,,	Killybegs, Rockmount .	2·79	71

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean of Day M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	° F.		° F.		° F.	° F.	° F.	° F.
London, Kew Observatory	1016·1	+2·2	56	31	21	13	44·6	37·4	41·0	+0·7
Gibraltar	1019·2	−0·4	71	2	43	16, 21	61·4	48·4	54·9	−1·1
Malta	1015·8	−0·1	67	7	50	26	62·1	54·2	58·1	+1·1
Sierra Leone	1011·6	+0·5	93	23	69	31	89·7	72·7	81·2	−0·3
Lagos, Nigeria	1012·6	+2·1	90	14	68	28	87·9	75·8	81·9	+0·6
Kaduna, Nigeria	1014·3	+4·2	92	21	49	14	86·5	55·0	70·8	−1·6
Zomba, Nyasaland	1008·8	+0·2	89	20	59	31	81·5	64·3	72·9	+0·2
Salisbury, Rhodesia	1009·0	−1·9	95	3	54	5, 15	84·8	59·3	72·1	+2·1
Cape Town	1013·7	−0·6	93	3	50	24	77·3	59·1	68·2	+0·6
Johannesburg	1010·5	0·0	86	5	45	15	78·4	54·1	66·3	+1·2
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1013·6	−2·1	81	2	50	30	78·2	55·0	66·6	+0·1
Bombay	1010·0	−3·3	90	17	65	26	85·4	69·7	77·5	+0·2
Madras	1013·0	−0·6	87	29	63	13	84·7	68·4	76·5	0·0
Colombo, Ceylon	1010·9	+1·1	88	25, 29	63	5	86·0	71·1	78·5	−1·2
Hong Kong	1017·5	−2·4	77	3	53	14	68·7	61·3	65·0	+2·1
Sydney	1009·9	−2·0	92	22	57	11	76·7	63·5	70·1	+0·1
Melbourne	1011·3	−1·0	106	23	45	17	66.6	58·1	62·3	−2·4
Adelaide	1012·0	−1·2	110	24	48	8	83·5	60·3	71·9	+0·7
Perth, Western Australia	..	..	..	..	..	..	..	..	..	..
Coolgardie	1010·2	−1·0	105	19	45	13	91·6	59·2	75·4	−0·4
Brisbane	..	..	..	..	..	..	..	..	..	..
Hobart, Tasmania	1015·2	+5·5	102	24	40	8	69·8	52·1	60·9	+0·5
Wellington, N.Z.	1011·9	−0·2	75	18	45	24	66·2	54·4	60·3	−0·2
Suva, Fiji	1007·9	−0·7	90	17	71	23	84·6	73·5	79·1	+0·2
Kingston, Jamaica	1013·7	−0·5	91	1	67	12	88·0	70·4	79·2	+1·5
Grenada, W.I.	1012·3	+0·4	88	15	72	7, 12, 15	83·3	73·7	78·5	+0·4
Toronto	1012·9	−4·5	51	14	10	29	36·6	26·4	31·5	+5·3
Winnipeg	1015·4	−2·5	33	1, 31	−22	27	18·7	4·5	11·6	+5·9
St. John, N.B.	1011·4	−2·8	51	2	− 8	26	31·3	20·3	25·8	+1·4
Victoria, B.C.	1010·2	−6·6	51	1, 28	32	14	45·5	39·6	42·6	+1·1
Suva, Fiji.										
January 1920	1007·1	−0·6	88	27	69	7	84·7	73·3	79·0	−0·9
February 1920	1004·2	−3·5	89	28	69	22	85·0	74·4	79·7	−0·8
March 1920	1008·7	+0·2	91	4	72	30	85·3	73·9	79·6	−0·5

January, 7 days with thunder heard; February, 11 days with thunder heard; March, 1 day with thunder heard.

London, Kew Observatory.—Mean speed of wind 8·9 mi/hr; 7 fogs, 6 days with snow.
Gibraltar.—2 fogs; 2 days with gale.
Malta.—Prevailing wind direction NW.; mean speed 8·2 mi/hr.
Sierra Leone.—Wind variable, chiefly calm; 2 days with thunder heard.
Salisbury, Rhodesia.—Prevailing wind direction E.
Colombo, Ceylon.—Prevailing wind direction N.; mean speed 5·0 mi/hr; 6 days with thunder heard.

British Empire, December 1920.

TEMPERATURE Absolute Max. in Sun ° F.	TEMPERATURE Absolute Min. on Grass ° F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
89	10	86	8·2	1·94	49	− 9	17	0·9	11	London, Kew Observatory.
120	35	78	4·5	4·79	122	− 18	7	..	..	Gibraltar.
117	..	79	5·6	1·44	37	− 49	10	5·9	61	Malta.
..	..	69	2·9	0·14	4	− 34	2	..	..	Sierra Leone.
156	61	70	6·3	0·04	1	− 20	1	..	..	Lagos, Nigeria.
..	..	37	..	0·00	0	− 3	0	..	..	Kaduna, Nigeria.
..	..	86	6·9	9·89	251	− 40	19	..	..	Zomba, Nyasaland.
151	55	64	4·7	4·93	125	− 29	14	..	..	Salisbury, Rhodesia.
..	..	57	3·6	1·67	42	+ 20	7	..	..	Cape Town.
..	44	57	5·3	3·35	85	− 38	9	9·3	68	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
..	..	..	..	..	..	..	..	..	..	Bloemfontein.
..	41	47	0·1	0·00	0	− 5	0	..	..	Calcutta, Alipore Obsy.
133	55	61	0·3	0·00	0	− 2	0	..	..	Bombay.
..	..	79	2·9	0·01	trace	−158	1	..	..	Madras.
160	55	68	4·4	4·42	112	− 28	11	..	..	Colombo, Ceylon.
..	..	74	7·9	1·81	46	+ 15	8	3·4	32	Hong Kong.
145	47	69	5·0	15·82	402	+335	16	7·8	54	Sydney.
156	41	54	4·9	0·99	25	− 34	8	..	..	Melbourne.
164	38	43	3·1	2·10	53	+ 29	7	..	..	Adelaide.
..	..	..	..	..	..	..	..	..	..	Perth, Western Australia.
165	43	30	1·7	0·02	1	− 17	1	..	..	Coolgardie.
..	..	..	..	..	..	..	..	..	..	Brisbane.
161	34	59	6·9	3·09	78	+ 28	12	7·9	52	Hobart, Tasmania.
152	34	72	6·0	1·67	42	− 40	6	7·1	47	Wellington, N.Z.
..	..	88	5·7	17·62	448	+140	26	..	..	Suva, Fiji.
..	..	71	3·7	0·02	1	− 40	1	..	..	Kingston, Jamaica.
144	..	73	3·8	4·06	103	− 85	14	..	..	Grenada, W.I.
..	..	83	8·8	3·04	77	+ 5	14	..	..	Toronto.
..	..	95	5·8	0·78	20	− 4	3	..	..	Winnipeg.
..	..	82	6·7	4·70	119	+ 13	16	..	..	St. John, N.B.
..	..	89	8·7	4·62	117	− 33	25	..	..	Victoria, B.C.
				Suva, Fiji.						
..	..	85	5·7	5·22	133	−139	24	..	..	January 1920.
..	..	92	4·9	12·20	310	+ 53	24	..	..	February 1920.
..	..	88	5·1	14·42	366	− 7	26	..	..	March 1920.

HONG KONG.—Prevailing wind direction ENE. ; mean speed 12·0 mi/hr.
SYDNEY.—Heaviest rainfall on record for Sydney.
SUVA, FIJI.—4 days with thunder heard.
GRENADA.—Prevailing wind direction E.
TORONTO.—2 days with fog.
WINNIPEG.—2 days with fog.
ST. JOHN, N.B.—1 day with thunder heard.
VICTORIA, B.C.—1 day with fog.

Violent rain and severe hail produced havoc in the vineyards of the Valley of the Arce, in the Champagne district of France. As this followed the black frost of April 15th–17th in the adjacent Burgundy district, the season promises to be disastrous. There has not been a good year for Burgundies since 1917.

Rainstorms in the Segura basin have caused the flooding of many villages and the destruction of crops in the Spanish province of Murcia. Serious floods are also reported in the Maia district of the province of Douro in Portugal.

In spite of the recent prolonged drought in the Alps, the upper glacier at Grindelwald is still moving downwards more than half an inch hourly; it is feared that it may reach the generating station of the Wetterhorn aerial railway next winter.

A shower of frogs is reported to have fallen on the North Front at Gibraltar during a thunderstorm. The possibility of frogs being carried from some marsh or lake by a whirlwind must be admitted in view of the well-authenticated shower of fish at Sunderland on August 24th, 1918.

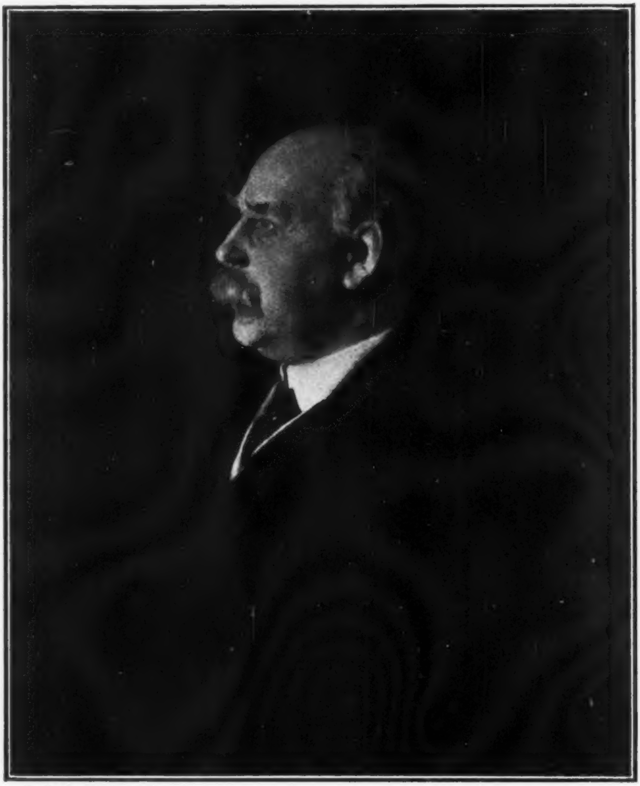
After a long spell of dry weather beneficial rain fell in Victoria, South Australia, and New South Wales, and the outlook for the coming season has considerably brightened.

The rainfall of the month was below the average in England and Wales generally, while a large part of the west of Scotland and isolated areas elsewhere experienced a moderate excess. The general rainfall, expressed as a percentage of the average, was:—England and Wales, 79; Scotland, 108; Ireland, 90; British Isles, 91.

Less than 25 mm. (1 inch) fell during the month over part of the east coast and as much as 50 mm. (2 inches) fell only extremely locally in any part of the east. The fall over the rainy areas of Wales was nearly everywhere below 100 mm. (4 inches), but more than 150 mm. (6 inches) fell in the Central Lake District and over much of the West Highlands. In Ireland the fall was more moderate, varying from rather more than 100 mm. (4 inches) to rather less than (50 mm.) 2 inches in the east.

May was the fourth successive month with general rainfall below the average in England. The area which experienced a defective fall in each of the four months comprised a very broad belt of country extending from Devonshire and Sussex in the south, across England to Haddingtonshire. At Totland Bay, in the Isle of Wight, the total fall was lower than in any previous four spring months except during the great spring drought of 1893.

In London (Camden Square) the month was beautifully fine, sunny and warm, with deficient rainfall. Mean temperature was 57·0° F., or 2·5° F. above the average. Duration of rainfall, 25·3 hours. Evaporation, 3·04 inches.



P. Laib, Photographer.

SIR NAPIER SHAW, F.R.S.

From the Painting by W. W. Russell, A.R.A.

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